Students' time spent on learning, study strategies and learning outcomes

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Draft

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Abstract

This study examines the relationships between students' perceptions of heavy study load, time spent on learning, study strategies, and learning outcomes. Student's study strategies were measured with a short version of Vermunt's Inventory of Learning Styles. It was possible to replicate 5 processing and 5 regulation strategies. The higher order dimensions meaning directed learning style (relate and structure, concrete processing, critical processing) and reproduction directed learning style (memorize and repeat, analyze, self-regulation of contents, process and results, external regulation of the learning process) differed from Vermunt. The scales showed differences across groups, which is in line with previous research. Linear structural analysis showed that reproduction directed learning precedes meaning directed learning. Only meaning directed learning affected GPA, the influence of the two learning styles on ECs was not evidenced in this study. Contact hours influenced ECs, but this effect was tempered through its negative association with a heavy study load. The limitations, implications for practice, and directions for further research and development will be discussed in the round table.

Context and problem

The context of the study is a university of applied sciences (UAS). Important components of the educational approach of this university are the direct contact between teachers and students and active and cooperative learning. In this approach, contact time, hours during which students interact with students and teachers, time scheduled for working on assignments with other students, and independent study are essential. In addition, it is expected that contact hours affect student's study success and the effectiveness of programs. In this context it seems to be an anomaly that many course evaluations in higher education focus on students' satisfaction with the learning environment and teachers' behaviors. Satisfaction is related with students' learning, it may also be a predictor of learning outcomes, but it is questionable whether satisfaction is related to the quality of the learning process. Course evaluations based on conceptions of learning may be more appropriate for generating feedback on the educational approach of teachers and programs of this UAS.

This study reports on the attempts to replicate an existing instrument (Vermunt, 1992) which measures how students learn, and to connect student learning with some other characteristics of the educational model used in this institution, i.e., students' time spent on different learning activities and the experienced study load which results from these activities. The information collected with such an instrument may facilitate teachers in getting grip on student learning and adjusting their teaching accordingly. Vermunt's (1992, 1996, 1998) Inventory of Learning Styles (ILS) was a natural candidate for this purpose for several reasons. The ILS proved to be a reliable tool and showed consistent differences across groups in the context of university education. Coffield, Moseley, Hall, & Ecclestone (2004) reported Vermunt's model as one of the more influential models, with many practical implications. It opens up possibilities for students to become aware of how they learn and for both students and teachers to influence students' study strategies.

The general aim of this study was to adjust, where necessary, the phrasing of the items of Vermunt's ILS to the vocational context of a UAS, and to re-assess its reliability and verify the validity. Reliability in this context means that the Vermunt's (1992, 1996, 1998) constructs about student learning can be reproduced among UAS-students. Validity means that the constructs show differences between groups of students which are meaningful and in line with results of previous research.

Theoretical framework

The concepts examined in this study are learning styles, time spent on study, study load, and study success. The concepts are defined as follows.

Learning styles

Vermunt (1992, 1996, 1998) distinguished between mental learning models, learning orientations, regulation strategies and processing strategies. Processing strategies refer to the cognitive activities which students deploy in order to process information and to attain their learning goals. These activities are aimed at facts, concepts, formulas, lines of reasoning, definitions, theories, visions and conclusions (Vermunt, 1992). The main processing strategies are (a) deep processing, consisting of learning activities such as relating, structuring, and critical processing, (b) stepwise processing, with analyzing and memorizing as characteristic activities and (c) concrete processing, characterized by 'concretizing' and applying (Vermunt & Vermetten, 2004). Regulation strategies steer students' cognitive activities (Vermunt & Vermetten, 2004). Regulation strategies can be self-regulated, when the student is the agent of his/her learning process, but also externally regulated, when a student takes a dependent attitude in which the regulatory activities of teachers determine his/her learning activities; a lack of regulation refers to the situation when students themselves do not regulate the learning activities and don't feel supported by teachers (Vermunt & Vermetten, 2004). Processing and regulation strategies are related to students' conceptions of knowledge and beliefs about learning (their learning models) and to their goals, motivations, intentions, attitudes, expectations, and doubts about learning (their learning orientations) (Vermunt & Vermetten, 2004). Vermunt combined the different modes of mental learning models, learning orientations, regulation strategies and processing strategies into four different learning styles or patterns. Undirected and reproduction-directed learning are less desirable, and meaning-directed and application-directed learning are more desirable in relationship to study success. In the present study we focused on regulation strategies and study strategies.

Characteristics of the teaching-learning environment such as the type of knowledge, the emphasis of a discipline on soft/hard and pure/applied knowledge, and the teaching methods may affect the sort of learning activities students deploy. For example, students' learning activities in health care studies involves learning by heart of many facts about the human body; independent study is very important in this regard. In contrast, in engineering studies, laboratory work done together with other students is much a common actvitity, and in social work studies discussions about values and professional attitude in complex social systems is a recurrent learning activity. In some programmes students have a full-time schedule of contact-hours, with relatively little time left for individual assignments and independent study. In other programmes the scheduled contact hours reserved for lectures are less intensive, and group assignments and independent study of the learning contents are more important. These differences also reflect the differences in epistemology between the bodies of knowledge of different disciplines (Becher, 1994). Many authors noticed the existence of these disciplinary differences in the domain of students' learning patterns and activities (Entwistle & Peterson, 2004; Wierstra, Kanselaar, Van der Linden, Lodewijks, & Vermunt, 2003; Vermunt, 1992, 2005). Many researchers found that disciplinary differences relate to variance in study progress (e.g., Beekhoven, De Jong, & Van Hout, 2003).

Time spent on study

Time spent on study is important for study success (Carroll, 1963; Suhre et al., 2007; Van den Berg & Hofman, 2005). Time spent on study consists of time devoted to (a) attendance of scheduled contact hours and individual contacts with teachers, (b) group work in which assignments are made together with other students, and (c) independent study, consisting of individual assignments, homework, and preparation for examinations, outside the presence of teachers. The time spent on passive or active contacts with teachers and other students, group work, and independent study may have different influences on study success. Torenbeek, Suhre, Jansen, & Bruinsma (2011) found that active contact hours increase grades as well as GPA in higher education. Active and independent study time are more important for study progress than 'simple' (passive) contact hours (Suhre et al., 2007). The number of contact hours, even if this time is spent in active learning, is a necessary but not sufficient condition for greater effectiveness and shorter study duration of medical students (Schmidt, 2012; Schmidt, Cohen-Schotanus & Arends, 2009). Independent study hours seem to be more profitable for learning activities such as analyzing, relating, structuring, and critical processing. These activities are rather elements of the more desirable meaning-directed and application directed learning than undirected or reproduction-oriented learning.

Study load

'Objective' study load is the estimated or planned time which is needed to attain a course. Passing all the exams of one academic year means that a student has attained 60 credit points, the 'realized' study load. An average student has to study 1680 hours to attain 60 credit points. Generally, in Dutch UAS, students realize a study load which is on average lower than 60 credits per year. Realized study load is frequently associated with subjective study load. We define subjective study load as the experienced study load. The subjective study load depends on students' perceptions of the effort which is required by the program, and can be lower or higher than, or the same as, the objective study load. Factors such as time management skills, motivation, regularly study behavior, and stress may affect subjective study load (cf. Macan, 2000; Jansen & Suhre, 2010). Students' background characteristics such as gender, age, and prior education may also be related with students' perceptions of subjective study load. For example, students with a low GPA in secondary education or with deficient qualification profile experience a higher study load than other students. Furthermore, the disciplinary context and other program factors can impact on subjective study load. The level of the program, an uneven spread of exams, or too much contact hours can induce a high subjective study load, and through this variable contribute to procrastination behavior, and result in less study success (Hanson & Sinclair, 2008; Jansen, 1996; Lizzio, Wilson, & Simons, 2002). Entwistle & Peterson (2004; cited from Ramsden, 1983) reported students' perception of 'good teaching' and 'freedom to choose' to be associated with a deep approach to learning, and a 'lack of freedom' with a surface approach and a high study load.

In sum, a study load which is experienced as too high can be detrimental for engagement, the deployment of desirable study strategies and, subsequently, study success.

Study success

In this study, in order to validate Vermunt's adjusted ILS, we related learning styles, time spent on study, and subjective study load, with study success. As indicators for study success, we distinguished between (a) study progress, the number of credits attained in one academic year ('realized' study load), and (b) grade point average, or the average of grades attained for the different subjects in one year.

Conceptual model

In sum, time spent on study, the use of study strategies, subjective study, and study success are focus of the validation-part of this study. The relationships are depicted in the following figure.

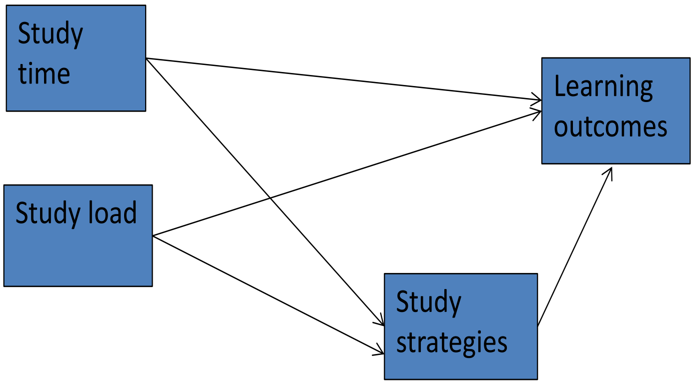

Figure 1: conceptual model

The figure shows that the time students spent on study, i.e., contact hours, group assignments and independent study, affects the study strategies they use. The experienced (subjective) study load affects the use of study strategies. Together, time spent on study, subjective study load, and study strategies determine study success to a certain extent.

Research questions

This study aims to answer the following research questions:

1. A. Is it possible to find the same patterns of regulation and processing strategies for UAS-students? For the practical reason that the length of the questionnaire should not be too large, it was decided to use only a part of the ILS-instrument of Vermunt (1992).

   B. Is it possible, on a higher level, to relate these strategies to Vermunt's (1992) dimensions meaning-directed, application-directed, reproduction-directed and undirected learning?
2. Assuming that it is possible to find ILS- or ILS-like scales: Do regulation and processing strategies differ across groups of students?
3. What are the relationships between learning styles, subjective study load, time spent on studying, and study success?

Research Method

Data collection

The data collection for the study was conducted in two shifts. In December 2012, 137 first- and second-year students filled in a shortened and adjusted ILS-questionnaire. The questionnaire was administered to students in the disciplines Economics, Health, Social Studies, and Engineering. In May 2013, 77 first-year Engineering students (Building & construction N = 45, Civil engineering N = 32) completed the same questionnaire, this time extended with questions about experienced study load and time spent on study.

Instrument

The ILS (Vermunt, 1992, p. 108/109) was the starting point for the measurement of students' study strategies. Some items were slightly adjusted to fit better with UAS-students. The core of our instrument consists of 30 items (see Appendix 1):

- Processing strategies (15 items, 3 items per cluster): relate and structure, memorize and repeat, concrete processing, analyze, and critical processing.
- Regulation strategies (15 items, 3 items per cluster): external regulation of the learning process, self-regulation of learning process & results, self-regulation of learning contents, lack of regulation, external regulation of learning results.

The 77 students who were approached in May were also asked to answer questions about study load and time investment.

- Subjective study load was measured by 7 items. For example, 'I usually have enough time to prepare for exams or assignments'. The 7 items were subjected to a factor analysis, resulting in three dimensions which explained 66% of the variance. However, the analysis resulted only in one acceptable scale 'study load' (Cronbach's alpha = 0.68). This variable was used in further analysis.
- Finally, students were asked to assess how much time they spend on average per week to contact hours, group work (cooperating with others), and independent study.

Analysis

Factor analysis, with principal components analysis and varimax rotation, was conducted on the items of the 30 ILS- items (N = 137 +77). Subsequently, reliability analysis was conducted in order to determine whether it was allowed to summarize several items into one score. Group differences were analyzed with multivariate analysis of variance (N = 214). The relationships were analyzed with correlations and linear structural (lisrel) analysis for a reduced number of variables. The covariance matrix was used as input for the lisrel analysis (N = 70, listwise deletion). The indicators used to estimate the fit of the model were: chisquare (with a cut-off value of $p > .05$), root mean square residual (cut-off value < .05), and standardized root mean square residual (cut-off value > .95). The paths in the initial model were based on significant correlations ($p < .05$) (see Appendix 4).

Results

Dimensions

The first research question was whether it was possible to find the same dimensions as in Vermunt's original ILS, with the restriction that we used a selection of 30 items. The results of the factor and reliability analysis are included in Appendix 2 (Information processing strategies) and Appendix 3 (Regulation strategies). The results confirmed the existence of five dimensions underlying the 15 items of information processing, with factor loading > .40. The five scales were internally consistent with Cronbach's alpha between .66 and .72.
The results of the second factor analysis showed similar results for the 15 items of regulation strategies, with high factor loadings for each dimension and acceptable reliability coefficients between .61 and .81. The results are summarized in Table 1.

Table 1: Outcomes factor and reliability analysis

	items	Cronbach's alpha
Information processing		
Memorize and repeat	3	.69
Analyze	3	.69
Critical processing	3	.66
Relate and structure	3	.66
Concrete processing	3	.72
Regulation strategies		
Selfregulation of contents	3	.81
External regulation of learning outcomes	3	.69
Undirected learning behavior	3	.68
External regulation of learning process	3	.61
Selfregulation of learning process and outcomes	3	.62

The first research question also involved the conduct of a third factor analysis on the scale-variables found in the previous analysis. Vermunt (1992) distinguished four different learning styles or patterns: meaning-directed, application-directed, undirected and reproduction-directed learning. In Vermunt's analysis, the construction of these learning styles was based on different modes of mental learning, learning orientations, processing strategies and regulation strategies. In the present study only the 10 scales on processing and regulation strategies (as presented in Table 1) were included in the third factor analysis. The factor loadings and other results of this analysis are included in Appendix 4. Like Vermunt, we found four dimensions, together explaining 70.0% of the variance. The results are summarized and the loadings of the dimensions compared with Vermunt's results (1992, Tabel 5.7, p. 116) in Table 2.

Table 2: Results second order factor analysis in this study compared with Vermunt 's (1992)

Vermunt	This study
'Meaning-directed learning	*Factor 1*
relate and structure	relate and structure
critical	critical
concrete	concrete
selfregulation learning proces & results	selfregulation learning process & results
selfregulation learning contents	
Reproduction oriented learning	*Factor 2*
memorize and repeat	memorize and repeat
analyse	analyse
external regulation learning process	external regulation learning process
external regulation learning results	selfregulation learning process & results
Application-oriented learning	*Factor 3*
concrete	selfregulation learning process & results
external regulation learning results	selfregulation learning contents
	lack of regulation
Undirected learning	*Factor 4*
lack of regulation	external regulation learning results

Note : $\longrightarrow$ = approximately the same result; $\dashrightarrow$ = different result

Table 2 shows that the results of the present analysis were very much the same as Vermunt's. A few differences emerge though. The dimension meaning-directed learning found among UAS students does not include 'self-regulation of learning content' and self-regulation of learning process & results'. Instead, these scales loaded on 'reproduction directed learning'. Furthermore, the scale 'external regulation of learning results' loaded on the dimension 'application directed', whereas in Vermunt's work this scale is component of reproduction-oriented learning.

In the remainder of this study, we continue with the two strongest dimensions of the last factor analysis:

- *meaning-directed learning* (relate and structure, concrete, and critical processing)
- *reproduction-directed learning* (with memorize & repeat, and analyze as processing strategies, and with self-regulation of contents as well as process & results, and external regulation of the learning process as components).

We emphasize once more that these variables have a slightly different meaning than in Vermunt (1992).

Differences across groups

The second research question was formulated as: Do regulation and processing strategies, time spent on study, subjective study load, and study success, differ across groups of students? We distinguished different groups along the characteristics of prior education (secondary general education or senior secondary vocational education/pre-university education), program (Civil Engineering or Building & Construction) and gender. The results are presented in Table 3.

Table 3: Results of the multivariate analysis with 5 information processing and 5 regulation strategies, meaning directed and reproduction directed learning style as dependent variables.

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	,730	27,879^b	10,000	103,000	,000
	Wilks' Lambda	,270	27,879^b	10,000	103,000	,000
	Hotelling's Trace	2,707	27,879^b	10,000	103,000	,000
	Roy's Largest Root	2,707	27,879^b	10,000	103,000	,000
Gender	Pillai's Trace	,196	2,515^b	10,000	103,000	,010
	Wilks' Lambda	,804	2,515^b	10,000	103,000	,010
	Hotelling's Trace	,244	2,515^b	10,000	103,000	,010
	Roy's Largest Root	,244	2,515^b	10,000	103,000	,010
Secondary General Education	Pillai's Trace	,066	,726^b	10,000	103,000	,699
	Wilks' Lambda	,934	,726^b	10,000	103,000	,699
	Hotelling's Trace	,070	,726^b	10,000	103,000	,699
	Roy's Largest Root	,070	,726^b	10,000	103,000	,699

Effect		Value	F	Hypothesis df	Error df	Sig.
Senior Secondary Vocational Education	Pillai's Trace	,112	1,296[b]	10,000	103,000	,243
	Wilks' Lambda	,888	1,296[b]	10,000	103,000	,243
	Hotelling's Trace	,126	1,296[b]	10,000	103,000	,243
	Roy's Largest Root	,126	1,296[b]	10,000	103,000	,243
Building & Construction	Pillai's Trace	,217	2,849[b]	10,000	103,000	,004
	Wilks' Lambda	,783	2,849[b]	10,000	103,000	,004
	Hotelling's Trace	,277	2,849[b]	10,000	103,000	,004
	Roy's Largest Root	,277	2,849[b]	10,000	103,000	,004

The results indicated differences in learning styles across gender ($F=2.515$, $p = .010$) and programme ($F = 2.849$, $p = .004$). Women scored a higher 3.24 (sd = .90) on 'memorize and repeat' compared to the men's 2.84 (sd = .79), had a score of 2.90 (sd = .82) on analyse against 2.51 (sd = .75) of men. Similar differences were found for 'external regulation of the learning process' (women = 3.18, sd = .95; men = 2.76, sd = .76) and 'self-regulation of learning contents' (women = 2.66, sd = .99; men = 2.21, sd = .92). Finally, as a consequence of the foregoing, women also had a higher score on 'meaning-directed learning' (mean = 2.97, sd = .61) than men (mean = 2.59, sd = .56). Furthermore, Building & Construction students scored higher than Civil engineering students on 'analyse', self-regulation of the learning process & results', self-regulation of learning contents', and 'meaning-directed learning'. On an average they had scores between 2.72 and 2.86 (sd's =.49 - .80), against average scores between 2.01 and 2.56 for the Civil engineering students (sd's =.63 - .91).

Relationships

The third research question involved the relationships between learning styles, subjective study load, time spent on studying, and study success. Due to the limited number of complete cases ($N = 70$) it was not possible to include the 5 information processing and the 5 regulation variables into the linear structural analysis. Instead, we used the scales *meaning-directed learning* and *reproduction-directed learning* found in the earlier stage of the analysis. As gender showed significant differences on meaning-directed learning, we also included this variable in the analysis. The analysis had an exploratory character. The result of the analysis with Grade Point Average as dependent variable is depicted in Figure 2. The model explains 17% of the variance in GPA. The results with attained number of credit points as dependent variable is depicted in Figure 3, with 18 % explained variance in ECs.

Figure 2 shows that gender influences the number of hours students spent on cooperating with other student. That is, men spent more time on this work form than women (path coefficient = -.33). On the other hand, women spent more time on independent study and have a more reproduction directed learning style. Furthermore, Figure 2 shows that the number of contact hours has a negative influence on subjective study load. This means that students who reported to attend more contact hours experience a higher study load. As the relationship between subjective study load and GPA is positive, meaning that students who reported a lower study load attain higher grade points on average, the number of contact hours tends to negatively affect GPA through subjective study load. I.e., this effect is -.28 * .26 = -.0728 (but not significant in the model). The other two forms of work do not influence subjective study load nor GPA. The Figure also shows that a reproduction directed learning has a clear influence (path = .45) on meaning directed learning. Through this variable, reproduction directed learning affects GPA, with a total effect of .45 * .26 = .117. However, the total effect of meaning directed learning is higher, namely .26 (equal to the direct effect on GPA). Finally it should be noticed that

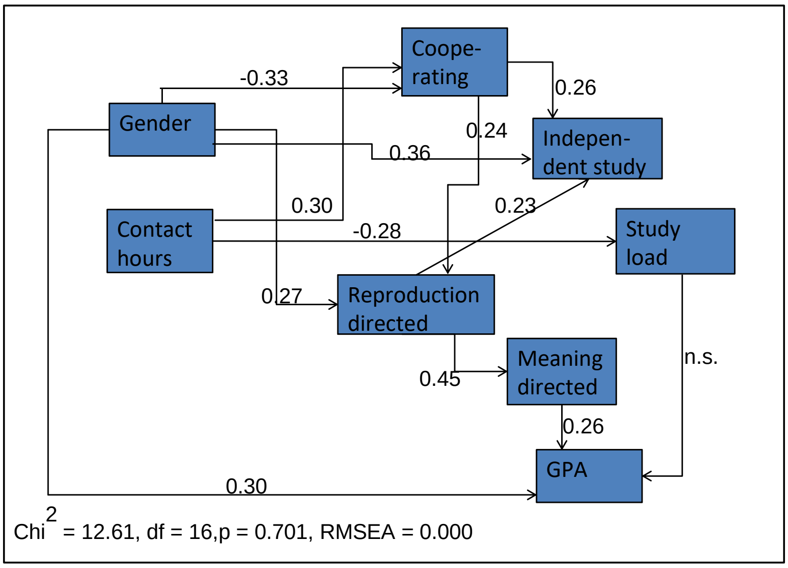

Figure 2: Standardised direct effects in lisrel-model with GPA as dependent variable.

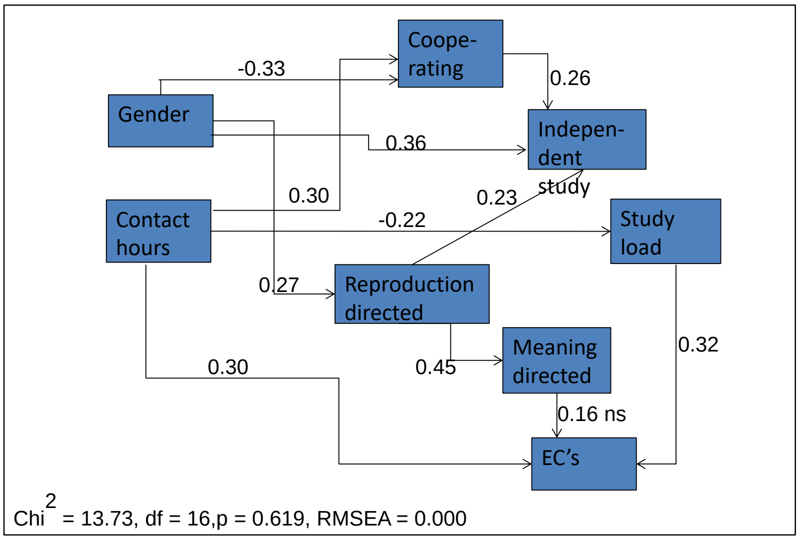

Figure 3: Standardised direct effects in lisrel-model with ECs as dependent variable.

cooperating is important in two ways. This variable influences the time students devote to independent study. Second, cooperating has a positive influence on reproduction learning, and thus contributes, although rather modestly, to GPA (.24 * .45 * .26 = .028.

Figure 3 very much resembles the previous figure. However, two differences emerge. First, the influence of meaning directed learning (path = .16) is not significant in this model. Second, cooperating does not affect reproduction directed learning.

A summary of the results of the linear structural models, the total effects of the two models are presented in Table 4. In descending order, gender, meaning directed learning and reproduction directed learning influence GPA. In explaining number of attained credits, subjective study load is the most important variable, followed by contact hours, meaning directed learning, and with smaller effects for reproduction directed learning and gender.

Table 4: Standardized total effects for the two models with GPA and ECs as dependent variable

		1	2	3	4	5	6	7
1. Gender	GPA ECs							
2. Contact hours	GPA ECs							
3. Cooperating	GPA ECs	-.33 -.33	.30 .30					
4. Independent Study	GPA ECs	.34 .34	.08 .08	.26 .26				.23 -
5. Study load	GPA ECs	-.08 -	-.21 -.22	.24 -			 .23	
6. Meaning directed	GPA ECs	.12 .12						.45 -
7. Reproduction directed	GPA ECs	.27 .27						
	GPA ECs	.33 .02	- .23			- .32	.26 .16*	.12 .07*

Note. * these total effects are included, based on the assumption that the path meaning directed learning → ECs is significant, which actually was not evidenced in the model (see Figure 3).

Tentative conclusions

The first research question of this paper involved, after re-phrasing some of its items, the re-assessment of the reliability and validity of a part of Vermunt's ILS in the vocational context of a Dutch UAS. Factor analysis resulted in the confirmation of the same scales in the domains of information processing strategies and regulation strategies. The reliability coefficients of these 10 first order scales were acceptable. A second-order factor analysis also indicated the existence of four dimensions. However, a comparison with the dimensions found by Vermunt indicated that some of the scale-variables had different loadings and in three cases pertained to different dimensions. In the present study we distinguished *meaning-directed learning*, with relating and structuring, concrete processing, and critical processing as contributing variables; and *reproduction-directed learning*, in which the scale-variables memorizing & repeating, and analyzing as processing strategies, self-regulation of contents, self-regulation as process & results, and external regulation of the learning process as regulation strategies clustered together. The reliability coefficients of the 2 second order scales were also acceptable.

The second research question concerned the validity of the 12 scales found in our study. The results indicated differences in learning styles for genders and programmes, but not prior education. Generally, these results were line with Vermunt's finding.

To further validate the instrument, the third part of the study pertained to the question whether it was possible to relate reproduction-directed and meaning-directed learning with the individual background factor gender, the process factors time spent on study, distinguished in contact hours, time for cooperating with other students, and independent study time, and with two indicators of study success, namely GPA and ECs. In the GPA-model, reproduction-directed learning affected meaning-directed learning and GPA (path coefficients of .45 and .12). Also meaning-directed learning and gender significantly affected on GPA (path coefficients of .12 and .33). However, none of the three indicators of time spent on study, nor subjective study load had significant influences on GPA. In the ECs-model, subjective study load and contact hours had the largest influences on attained number of credits (path coefficients of .33 and .23). The path coefficients of .16 and .07 indicated influences of meaning-directed learning and reproduction-directed learning. However, these influences were only forced by the assumption that meaning-directed had a direct effect on ECs, whereas this path was not significant (see Figure 3). When this path is omitted from the model, there are no effects of meaning-directed or reproduction-directed learning.

Our tentative conclusion is that the instrument seems to be reliable and valid, although we add that we still have some hesitations which will be explained in the final section.

Discussion

The practical relevance of the new course evaluation instrument is more tailored to the educational objectives of this UAS than the current instruments focusing on satisfaction. The instrument also addresses educational policy issues, such as the contribution of time spent on contact, cooperation, and independent study hours, reproduction-directed and meaning-directed learning, and subjective study load, to study success.

It was possible to replicate the findings of Vermunt to a large extent. However, it is interesting to see in the present study that self-regulation, be it on learning process & results or on contents, clustered with reproduction-directed learning, and not with meaning-directed learning as in Vermunt (1992). It seems that reproduction-directed learning takes a more central place in the present study. An explanation for this result could be that this study took place in the context of higher vocational education.

Furthermore, it is interesting to see that students of the two programs differ considerably in several aspects of learning styles. Are student factors, how the programs try to regulate student learning, or the different epistemologies of the two programs, causing these differences? This result and possible explanations need to be further examined and discussed with teachers and management of the two programs.

Contact time is important for study success in terms of ECs, as is meaning-directed learning, but only in terms of GPA. The contribution of meaning-directed learning to study success is less clear when it comes to ECs. Contact hours can contribute not only to the time students spend on cooperating with others, but through cooperating to reproduction-directed learning and even to meaning-directed learning. There is not a direct path between contact hours and these learning styles. However, the influence of contact hours on GPA was not proven in this study. We already pointed at the exploratory character of the linear structural analysis.

This study had some limitations. The lisrel-analysis was based on 70 complete cases, and only data of engineering students were used in this analysis. The data collection took place in two periods of the academic year. The authors had no alternative but to treat the two sets as one, but it could be questioned whether this is allowed. Concerning the use of Vermunt's ILS, only part of the items of his instrument were used in this study. The items on mental learning models and learning orientations were not used. Furthermore, the indicators for study success were not related to one specific course, although the suggestion may have existed among the respondents. Also, the instrument, as it is now, does not provide information on students' perceptions of how their teachers try to evoke certain learning patterns. The instrument does not give feedback to teachers on their didactic-pedagogical approach and how it affects student behavior. On the other hand, the teachers who participated in our study were enthusiastic about the potential of the instrument concerning information about student learning, as this issue is neglected in most of the current satisfaction-based course evaluations. Our most severe hesitation, however, concerns the discrepancy between the claims of theory on the significance of learning styles for study success and the relations found in empirical research. In our models the correlations of reproduction-directed and meaning-directed learning with GPA were .26 and .28 ($p < .05$). No correlation was found with ECs. In other studies these correlations are even smaller (e.g., Van de Mosselaer, Van Petegem, Van Dijk, & Michiels, 2012).

These limitations and hesitations lead to the following questions for further discussion during the round table:

- What are the experiences in other UAS/higher education institutions in using Vermunt's ILS?
- Is Vermunt's ILS a good starting point for course evaluations?
- Is the methodology used in the present study in your opinion – in essence – a sufficient base for validating and applying Vermunt's instrument in UAS?
- Does the influence of learning styles on study success as they are measured now offer a sufficient and convincing ground for use in UAS?

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Appendix 1: Selected items ILS (based on Vermunt, 1992).

	A. Information processing
1.	I try to combine the subjects that are dealt with separately in a course into one whole.
2.	I try to relate elements of the subject matter to the general idea of a course.
3.	I compare conclusions of different courses.
4.	I memorize lists of characteristics of a certain phenomenon.
5.	I prefer to memorize definitions.
6.	I repeat the most important components of a course until I know them by heart.
7.	I try to interpret daily events with the help of the knowledge I have acquired in a course.
8.	I use what I have learned in a course in activities outside my studies.
9.	I always pay particular attention to parts of a course which I can use in practice.
10.	I go through the subject matter in a stepwise fashion and study the separate elements thoroughly, in detail and one by one.
11.	I analyze the separate components of a theory step by step.
12.	I start with the next part of a course when I have mastered the current part completely.
13.	I try to be critical of the views of experts.
14.	I compare my view of a course topic with the views of *the teacher* or authors of the textbook used in that course. #
15.	I check whether the conclusions drawn by authors *or teachers* logically follow from the presented facts. #

items slightly different from Vermunt

	B. Regulation strategies
16.	I study according to the instructions in the course materials (*e.g., syllabus, blackboard*). #
17.	I use the introduction and the learning objectives (*e.g., syllabus, blackboard) to form an idea of what I have to learn.* #
18.	I do all the questions and exercises of the course materials as I encounter them in the text.
19.	To test my learning progress, I try to answer questions about the subject matter which I make up myself.
20.	When I have difficulties with course materials I try to diagnose the causes of these difficulties.
21.	When I start a new chapter or subject of the course, I start by thinking about the best way to study it.
22.	I *consult* literature and sources outside *the syllabus or course materials*.#
23.	I *try to* add additional sources to the course contents.#
24.	When I do not understand *course materials* I search for additional literature on that subject.
25.	I notice that it is difficult for me to determine whether I have mastered the subject matter sufficiently.
26.	I realize that it is not clear to me what I have to remember.
27.	I realize that learning objectives of a course are often too general for me to offer any support.
28.	The moment I am able to answer questions of a self-test, I decide that I have mastered the subject matter of a course sufficiently.
29.	The moment I am able to complete/answer all assignments and questions in the course materials, I decide I have mastered the subject matter of a course.
30.	I test my learning progress solely by completing the questions, tasks and self-test in the course materials.

items slightly different from Vermunt

Appendix 2: Outcomes factoranalysis Information processing items (Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization). N=215

	F1	F2	F3	F4	F5	
% Explained variance	13.4	13.0	13.0	12.6	12.1	
Eigenvalue	3.8	2.3	1.3	1.0	1.0	
Cronbach's alpha	0.69	0.69	0.66	0.66	0.72	item-total correlations
Memorise and repeat						
5. I prefer to memorize definitions.	,832					.55
4. I memorize lists of characteristics of a certain phenomenon.	,763					.56
6. I repeat the most important components of a course until I know them by heart.	,701	,341				.52
Analyse						
10. I go through the subject matter in a stepwise fashion and study the separate elements thoroughly, in detail and one by one.		,817				.61
12. I start with the next part of a course when I have mastered the current part completely.		,799				.50
11. I analyze the separate components of a theory step by step.	,340	,632				.43
Critical processing of information						
15. I check whether the conclusions drawn by authors or teachers logically follow from the presented facts.			,774			.50
14. I compare my view of a course topic with the views of the teacher or authors of the textbook used in that course.			,770			.52
13 I try to be critical of the views of experts.			,622			.40
Relate and structure						
1. I try to combine the subjects that are dealt with separately in a course into one whole.				,813		.50
3. I compare conclusions of different courses.				,677		.53
2. I try to relate elements of the subject matter to the general idea of a course.				,592		.41
Concrete processing						
8. I use what I have learned in a course in activities outside my studies.					,769	.57
9. I always pay particular attention to parts of a course which *h* I can use in practice.			,328		,761	.47
7. I try to interpret daily events with the help of the knowledge I have acquired in a course.				,492	,633	.48

Appendix 3: Outcomes factoranalysis Regulation strategy items (Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization). N=215

	F1	F2	F3	F4	F5	
% Explained variance	14.6	13.6	12.3	11.0	10.6	
Eigenvalue	3.8	1.9	1.6	1.2	0.9	
Cronbach's alpha	0.81	0.69	0.68	0.61	0.62	item-total correlations
Selfregulation of contents						
23 I try to add additional sources to the course contents.	,851					.69
22. I consult literature and sources outside the syllabus or course materials.	,838					.68
24. When I do not understand course materials I search for additional literature on that subject.	,704					.55
External regulation of learning outcomes						
29. The moment I am able to complete/answer all assignments and questions in the course materials, I decide I have mastered the subject matter of a course.		,861				.62
28. The moment I am able to answer questions of a self-test, I decide that I have mastered the subject matter of a course sufficiently.		,740				.49
30. I test my learning progress solely by completing the questions, tasks and self-test in the course materials.		,701				.42
Steerless learning behavior						
26. I realize that it is not clear to me what I have to remember.			,874			.59
25. I notice that it is difficult for me to determine whether I have mastered the subject matter sufficiently.			,759			.49
27. I realize that learning objectives of a course are often too general for me to offer any support.			,631			.42
External regulation of learning process						
17. I use the introduction and the learning objectives (e.g., syllabus, blackboard) to form an idea of what I have to learn.				,887		.46
16. I study according to the instructions in the course materials (e.g., syllabus, blackboard).		,362		,730		.52
18. I do all the questions and exercises of the course materials as I encounter them in the text.		,301		,302		.31
Selfregulation of learning process and outcomes						
21. When I start a new chapter or subject of the course, I start by thinking about the best way to study it.					,844	.36
20. When I have difficulties with course materials I try to diagnose the causes of these difficulties.					,551	.37
19. To test my learning progress, I try to answer questions about the subject matter which I make up myself.					,521	.31

Appendix 4. *Outcomes of the 'second order' factor analysis, compared with Vermunt (1992)*

		F1		F2		F3		F4		Diffe-rences
		This Study	Vermunt 'meaning directed'	This Study	Vermunt 'repro-duction'	This Study	Vermunt 'undi-rected'	This Study	Vermunt 'applica-tion'	
Deep information processing	• relate and structure	**.69**	.71							=
	• critical	**.82**	.74							=
Stepwise information processing	• memorize and repeat			**.86**	.64					=
	• analyse		(.30)	**.74**	.69					=
Concrete information processing	• concrete	**.82**	.57				(.43)			=
Self-regulation	• selfregulation learning contents	-	.69	(.36)	-	**.75**	-			#
	• selfregulation learning proces & results	-	.78	**.46**	-	**.49**				#
External regulation	• external regulation learning process			**.53**	.81			(.38)	-	=
	• external regulation learning results			-	.67			**.86**	-	#
Undirected learning	• lack of regulation					**.74**	.74	(.42)	-	=

Note: = approximately the same results; # different results

Appendix 5. Correlations

	Gender	Contact hours	Coopera-ting hours	Indep. study	Study load	Meaning directed l.	Repro-duction directed l.	GPA	ECs
Gender	1								
Contact hours	,119	1							
Cooperating hours	-,291*	,261*	1						
Indep. study	,347**	,187	,126	1					
Study load	,005	-,217	,167	,062	1				
Meaning directed l.	-,013	-,061	,110	,159	,077	1			
Reproduc-tion directed l.	,270	,098	-,119	,299*	,061	,455**	1		
GPA	,296*	,151	-,068	,100	,150	,258*	,281*	1	
ECs	,172	,222	,157	,122	,269*	,173	,102	,431**	1